

Cost & Contingency Analysis for the Rebaselined Run IIb D-Zero Detector Upgrade

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Introduction

There are two estimates of contingency made for the Project. One estimate is made by the WBS Level 3 Subproject Managers at the lowest available level. It is based on detailed estimates of designs where available, and on the experience of the Subproject Managers and the engineering staff directly involved with the subsystem where a conceptual design exists. Guidelines for the estimation of the contingency have been provided by the Project Manager, but may be overridden by the Subproject Managers in exceptional cases. For example, results of risk analyses can reveal tasks or sets of tasks for which the cost, schedule, or technical risks are found to be high. In this case, with proper justification, the Subproject Managers can increase the contingency in order to potentially mitigate the additional risk. The general guidelines for the contingency estimation for M&S are:

- 0% on items that have been completed,
- about 10-15% on items that have been ordered, but not delivered (this accommodates change orders, delivery costs, etc.),
- about 15-45% on items that can be readily estimated based on quotes for a detailed design,
- about 45-65% on items for which a detailed conceptual design exists, but which may vary due to scope changes such as channel count, and
- about 65-85% on items for which there does not yet exist a detailed conceptual design, but which is an item required for the Project.

The contingency estimates are passed on to the Project Manager after review and final approval by the WBS Level 2 Subproject Managers. The Project Manager constructs a “top-down” estimate of the contingency based on past experience, DOE guidelines, the fiscal history of similar completed projects, the advice of the Laboratory, the results of risk analyses, and the recommendations of Director's and IPR reviews. The Project Manager makes the ultimate determination of the M&S contingency, taking his own estimate and that constructed by the lower level managers into consideration. Contingency on labor is handled in an analogous fashion.

The contingency for each of the sub-systems previously baselined at the September 2002 DoE (“Lehman”) Review - trigger (WBS 1.2), data-acquisition and online (WBS 1.3), and project administration (WBS 1.4) - is consistent with both the guidelines above and the explicit recommendations of that Committee, and is presented in the following table. We discuss the contingency of the descoped silicon, or layer 0, detector (WBS 1.6) and the AFE II/TriP upgrade (WBS 1.2.8) in the following two sub-sections.

Previously baselined sub-system	Contingency on TEC
Trigger (WBS 1.2)	42% (AFE II/TriP not included)
DAQ/Online (WBS 1.3)	31%
Project Administration (WBS 1.4)	25%

Table 1: Contingency fractions on previously baselined subsystems that are part of the project rebaselining.

AFE II/TriP Upgrade

The AFE II, or second version of Analog Front-End boards for the Central Fiber Tracker (CFT), and the TriP chip, a new version of the trigger chip for the CFT, represents a considerable simplification of the current system. It is designed to provide more stable and uniform noise performance and is being designed to provide z-information for the tracks, both of which are anticipated to increase both on- and offline tracking efficiency.

The collaboration has extensive experience with the AFE boards from Run IIa, and the cost estimate is closely based directly on the original version of these boards. The technical and cost risks for the M&S portion of the cost estimate we consider to be reasonably small – there are substantial similarities between the two boards, and the part list has much overlap. Part of the uncertainty as to our ability to share the setup charges for the second, or pre-production, submission of the TriP chip with another Laboratory submission (BTev, for example) have been absorbed into the contingency. Taking these issues into consideration, we have assigned 35% to the contingency to the \$638k base M&S cost estimate of the AFE II/TriP upgrade.

As with all new board fabrications, there is some uncertainty as to the amount of labor required for layout, the number of submissions, and testing and possible rework of boards as they return from the vendor. This latter effort was significant for the original version of the AFE boards and, although we expect that the simplification of the new version and our prior experience will severely limit what is required here, we feel it prudent to properly cover the schedule risk with adequate contingency. We also note that an appropriate amount of contingency implies a rather large fractional contingency in the small amount of labor required for the base plan. We have therefore applied 70% contingency to the base labor estimate for the AFE II/TriP upgrade. The base labor estimate for the project is 1.0 (2.0) electrical technicians and 0.5 (1.0) electrical engineers in FY04 (05). Using the salaries adjusted by vacation and other paid time off (VAC/OPTO) and work efficiency factors used in baselining the original Run IIb upgrade, the total base labor cost in FY02\$ for the AFE II/TriP upgrade is \$470k.

The base M&S cost estimate in unburdened FY02\$ for the AFE II/TriP upgrade is shown in Table 2. It is expressed in terms of the first AFE project for Run IIa. We note that some parts for the AFE are not needed for the AFE II, and hence a negative cost adjustment is applied. Half the funds for a second TriP submission are included in the base cost; should no sharing with other projects be possible, the remainder will be taken out of contingency, if needed.

Bare AFE Boards	250	\$400	\$100,000
Parts Costs	250	\$800	\$200,000
Assembly Charges	250	\$600	\$150,000
packaging TRIP chips	5,000	\$5	\$25,000
Flash ADCs	5,000	\$8	\$40,000
Xilinx Spartan II	2,500	\$20	\$50,000
P/S parts (regulators)	2,500	\$20	\$50,000
CPLD cost adjustment	4,000	-\$10	-\$40,000
fifo cost adjustment	2,000	-\$10	-\$20,000
analog support adjustment	4,000	-\$10	-\$40,000
Develop TRIP test fixture	3	\$6,000	\$18,000
New Vicor Modules	17	\$300	\$5,100

BASE COST ESTIMATE \$538,100
TriP Submission \$100,000

NET BASE COST ESTIMATE \$638,100

Table 2: Base cost estimate in FY02\$ for the AFE II/TriP upgrade, expressed in terms of the initial AFE project (see text). Contingency of 35% (\$223k) is not included. Labor costs are discussed in the text.

Silicon Layer 0

Contingency for the Layer 0 project is based on our experience in the Run IIa and Run IIb silicon projects. Additional contingency was included to account for the short R&D and production phases. In most cases no prototypes are assumed and the costs of any second production runs would have to be taken out of contingency.

WBS #	System	M&S		FNAL		Labor		Total Cost	Cost + Cont.
		M&S Cost	Cont.	Labor	Cont.	Labor	Cont.		
1.6	Layer 0 Silicon Detector	\$782,184	73%	\$535,847	50%	\$1,374,921		\$2,216,270	
1.6.1	Sensors	\$164,200	100%	\$14,940	50%	\$179,140		\$350,810	
1.6.2	Readout Electronics	\$399,548	76%	\$198,629	50%	\$619,577		\$1,022,352	
1.6.3	Mechanical Design and Fabrication	\$139,025	50%	\$134,192	50%	\$273,217		\$409,726	
1.6.4	Layer 0 Detector Modules	\$16,711	75%	\$74,076	50%	\$90,787		\$140,328	
1.6.5	Final Detector Integration	\$25,700	50%	\$60,202	50%	\$85,902		\$128,853	
1.6.6	Monitoring	\$12,000	50%	\$0		\$12,000		\$18,000	
1.6.7	Software and Simulation	\$0		\$42,300	50%	\$42,300		\$63,450	
1.6.8	Project Administration	\$25,000	20%	\$11,508	50%	\$71,998		\$82,752	

Table 3: Cost and contingency values for the silicon layer 0 detector. Numbers are in FY02\$ with no G&A added.

The overall contingency on M&S is 73%. Contingency on labor has been set at 50%. Contingency for the sensors is set at 100% due to the uncertainty of the response of our preferred vendor, Hamamatsu, to the small quantities involved in the context of the cancellation of the Run IIb orders. Contingency on individual items in readout electronics varies from 50% to 100%, with 100% contingency placed on items associated with the adapter card system, which has only a conceptual design. Estimates for much of the mechanical fabrication are based on Run IIb prototype work and typically have been assigned 50% contingency. One hundred percent contingency was assigned to parts of the assembly process where only conceptual designs exist.